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Maternal Age as a Risk Factor for Wheezing Lower Respiratory Illnesses in the First Year of Life

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Postneonatal mortality due to respiratory illnesses is known to be inversely related to maternal age, but the possible role of young motherhood as a risk factor for respiratory morbidity in infants has not been thoroughly explored. The authors studied the incidence of lower respiratory tract illnesses during the first year of life, as ascertained by health plan pediatricians, in over 1,200 infants enrolled at birth between 1980 and 1984 in Tucson, Arizona. The incidence of wheezing lower respiratory tract illnesses increased significantly ($p = 0.005$) with decreasing maternal age, whereas the incidence of nonwheezing lower respiratory tract illness was independent of maternal age. A logistic regression was used to control for the effects of several known confounding factors. When compared with infants of mothers aged more than 30 years, adjusted odds ratios were 2.4 (95% confidence interval 1.8–3.1) for infants whose mothers were less than age 21 years ($p < 0.0001$), 1.8 (95% confidence interval 1.4–2.3) for infants whose mothers were aged 21–25 ($p < 0.0001$); and 1.4 (95% confidence interval 1.1–1.6) for infants whose mothers were aged 26–30 ($p < 0.001$). These results suggest that young motherhood is an important risk factor for wheezing lower respiratory tract illnesses during the first year of life. Both biological and social factors related to maternal age may explain these findings. *Am J Epidemiol* 1992;136:1258–68.

bronchiolitis; maternal age; men; women

In 1959, Morrison et al. (1) reported that postneonatal mortality for "respiratory diseases" and "accidents" (the latter including most cases of sudden, unexpected death) was highest among children of mothers aged less than 20 years and lowest among those of mothers age 30 or more. These trends associated with maternal age were particularly noticeable for deaths occurring between 4 weeks and 6 months of age and were independent of birth rank, social class, and region of the country where the family lived (1). No such trends were observed for deaths due to "congenital malformations." The authors suggested that younger mothers may take less care during pregnancy and may provide poorer care for their infants in the postnatal period. They speculated that real biological factors related to maternal age may also affect the infant's capacity to meet environmental stresses.

Since that study was published, the possible association of maternal age with infant mortality has been a subject of considerable scrutiny. A recent report by Friede et al. (2), based on over two million births, confirmed a significant inverse relation between maternal age (up to age 29 years) and postneonatal mortality, independent of birth weight and

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Abbreviations: CI, confidence interval; OR, odds ratio.

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race. The causes for this increased risk for infants of younger mothers have not been elucidated. Some authors stress the possible role of biological factors, especially those affecting fetal development during pregnancy (3), whereas others suggest that mothering skills and child-rearing practices may explain the reported associations (4).

A better understanding of the factors that enhance postneonatal mortality among younger mothers could come from studying the relation between maternal age and postneonatal morbidity. Unfortunately, very few such studies are available. This is probably attributable to the difficulties in performing well-controlled longitudinal studies during infancy. Studies based on maternal questionnaires, for example, may be biased by differences in illness and symptom reporting which are likely to occur among mothers of different levels of education.

The aim of this report is to examine the relation between maternal age and respiratory morbidity during the first year of life in a well-controlled, longitudinal study conducted in Tucson, Arizona. The Tucson Children's Respiratory Study (5, 6) has been designed as a prospective investigation of the risk factors for lower respiratory tract illnesses in infancy and their relation to chronic obstructive airway diseases later in life. Over 1,200 infants were enrolled at birth, and accurate records of lower respiratory tract illnesses occurring during infancy were kept by their pediatricians and study nurses.

MATERIALS AND METHODS

Detailed accounts of the study design, methods of enrollment, characteristics of the study subjects, and methods used to ascertain the presence of lower respiratory tract illnesses during infancy have been published previously (5, 6). The study nurses contacted all mothers who used the services of a health maintenance organization in Tucson, Arizona, who gave birth to a healthy baby during the enrollment period (May 1980–October 1984) and who were in the hospital on days when the nurses were available (usually 6 days a week). Healthy newborns were considered to be those who did not require oxygen for more than 6 hours after birth, had no major congenital anomalies, and had no symptomatic heart disease or severe systemic disease. A total of 1,246 infants (78 percent of those contacted) were enrolled. Since most families have medical insurance available through their employer, the great majority of the population may be considered middle class. Data on maternal age, maternal smoking habits, number of previous births, maternal education, marital status, ethnic origin, and birth weight were obtained at birth.

For this analysis, mothers were divided into five groups according to their age at the time of delivery: less than 21, 21–25, 26–30, 31–35, and more than 35 years. Initially, we intended to classify mothers in similar 5-year intervals, but starting with an age group of less than 20 years, as reported by others (2). However, because our study was based on families who used a health maintenance organization and because very young mothers are less likely to have this type of medical insurance, the number of mothers aged less than 20 was very small. This made results of risk analysis for this maternal age group quite unstable, particularly in stratified analysis. For this reason, children of mothers aged 20 years were added to the youngest maternal age group, and the classification described above was chosen. Results showed the same trends and, when statistically significant, were so with either method.

Mothers were classified as smokers if they reported smoking one or more cigarettes per day. Maternal education was classified as "high" if the woman had completed more than 12 years of formal education and as "low" otherwise. Marital status were classified as "unmarried" if mothers were single, separated, or divorced and as "married" otherwise. Children were classified as "Anglo" if they had at least one white, non-Mexican-American parent and as "Hispanic" if both parents defined themselves as being of Mexican-American origin. The few subjects who belonged to other ethnic groups (n = 55) were classified as "other."

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Data on feeding patterns were obtained both prospectively from well baby visits and retrospectively from questionnaires completed by parents. Infants were classified as being breast-fed if they had received mother's milk (regardless of whether other foods were given) for at least 1 month. In addition, information on day care was elicited during the child's second year, and parents were asked if the infant had spent 9 or more hours a week in the company of other children. In the same questionnaire, parents were asked if the infant had had physician-diagnosed eczema during the first year of life.

Total serum immunoglobulin E was measured in cord blood for 1,081 infants (86.8 percent) as described earlier (7).

Lower respiratory tract illnesses

Parents were instructed to take their child to their pediatrician if the child developed symptoms of lower respiratory illness (deep or "wet" chest cough, wheezing, hoarseness, stridor, or shortness of breath). To provide this service to its clients, the health maintenance organization charged them only a minimal fee for each visit. At the time of the acute illness, the physicians completed a standardized form on the presence or absence of a number of signs and symptoms. The study nurses, located in the pediatrician's offices, obtained additional historical information; cultures for viruses, mycoplasma, and chlamydia; and blood samples (6). Medical records were checked periodically to ensure that most or all lower respiratory tract illnesses were included. For the purpose of this study, only the first lower respiratory tract illness occurring during the first year of life was considered. Reports by the pediatricians or by parents at the time of the acute illness were used to classify lower respiratory tract illnesses as "wheezing" and "nonwheezing."

Only the 1,022 infants (82.0 percent) who remained under the care of the health maintenance organization pediatricians for the entire first year of life have been included (6). Because selective withdrawal from the study could be a source of bias, all subjects who stopped using the health maintenance organization pediatricians were excluded, and this included infants who had lower respiratory tract illnesses while still under their care.

Data analysis

The associations between maternal age and wheezing and nonwheezing lower respiratory tract illnesses were assessed for all infants at risk bivariately and after controlling for potential confounders. Odds ratios were used instead of ratios between incidences (or "relative risks") to allow for comparisons of results obtained from raw data analyses and those obtained from logistic regressions. Confidence intervals and statistical significance for trends in proportions were calculated by using the methods described by Rothman (8). A categorical logistic model was used to assess the independent effects of maternal age after simultaneously controlling for confounders (8, 9). This technique avoids a priori assumptions about the form of the relation between independent and dependent variables. Relevant independent variables (i.e., maternal age and birth rank) were stratified, and each stratum was then introduced as an independent regression variable. The risk of having lower respiratory tract illnesses in each stratum was compared with that of a predefined reference group, either the lowest or the highest for each variable; this baseline stratum has an odds ratio of unity. To assess linear trends for predictor variables, the logarithms of the odds ratios obtained from the logistic regression were plotted against the different levels of the predictor variable. If the observed data points approached linearity, the weighted least squares regression technique proposed by Rothman (8) was applied, taking the inverse of the variance of the odds ratios as the weight for each data point (stratum). Values used in this regression for each maternal age group were the mean age for that group. Likewise, the mean rank was used for infants born fourth or higher in rank. Because the outcome was a ratio, confidence intervals around the regression line were

TABLE 1. Comparison of subjects who were followed for the first year of life and those withdrawn from the study, Tucson, Arizona, 1980–1984*

Maternal age (years)†	Maternal smoking (% ≥1 cigarette/	Marital status (% married)	Day care use (%)	Breast feeding (% breast-fed)	Ethnicity			Maternal education (% <12 years)	Rank (%)			
					Anglo	Hispanic	Other		1	2	3	≥4

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TABLE 1. Comparison of subjects who were followed for the first year of life and those withdrawn from the study, Tucson, Arizona, 1980–1984*

	Maternal age (years)†	Maternal smoking (% ≥1 cigarette/day)	Marital status (% married)	Day care use (%)	Breast feeding (% breast-fed)	Ethnicity			Maternal education (% <12 years)	Rank (%)			
						Anglo	Hispanic	Other		1	2	3	≥4
Participants (n = 1,022)	27.6 ± 0.1	17.6	92.7	47.5	83.8	83.9	75.7	69.1	29.8	91.8	94.7	94.7	71.5
Withdrawn (n = 224)	25.7 ± 0.3	18.0	84.7	42.7	80.5	16.1	24.3	30.9	40.9	8.2	5.3	5.3	28.5
p value	<0.0001	0.9	<0.001	0.4	0.5	0.001			0.001	<0.0001			

* Not all values were obtained from the total number of participants or those dropped from the study because of missing data.
† Mean ± standard error.

always calculated using the logarithmic scale (8). Deviation from linearity was assessed by comparing goodness of fit χ^2 for linear and nonlinear models, as previously described (9, 10). In all logistic analyses, factors that could potentially modify or confound the relation under study were included in the analysis regardless of their statistical significance (8). All p values less than 0.05 were considered to be significant.

The study was approved by the Human Subjects Committee of the University of Arizona. Informed consent was obtained from parents at the time of enrollment.

RESULTS

Comparison of infants who were followed for the first year of life with those withdrawn from the study showed some important differences between these two groups (table 1). Mothers of participants were significantly older and better educated than were mothers of nonparticipants. In addition, Anglo children were significantly more likely to be followed for the entire first year of life than were Hispanic children and those of other ethnic origins. Finally, children with three or more siblings were significantly more likely to be withdrawn from the study than was the rest of the population.

Table 2 shows the relation between maternal age and other possible determinants of lower respiratory tract illnesses in the first year of life. Younger mothers tended to smoke more and to use day care facilities less for their children than did older mothers, although the associations did not reach statistical significance. They were also less likely to be Anglo or married, or to breast-feed than were older mothers. As expected, the proportion of mothers with more than 12 years of education increased significantly with maternal age, as did mean birth weight and rank (see below).

A total of 339 infants (33.2 percent) had lower respiratory tract illnesses during the first year of life. Information on symptoms during a lower respiratory tract illness was available for 285 infants (84.1 percent of all lower respiratory tract illnesses). Wheezing

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TABLE 2. Relation between maternal age and other possible determinants of lower respiratory tract illnesses for 1,022 infants studied in Tucson, Arizona, 1980–1984

Maternal age (years)	Maternal smoking (% ≥1 cigarette/day)	Marital status (% married)	Day care use (%)	Breast feeding (% breast-fed)	Ethnicity			Maternal education (% <12 years)	Birth weight (kg) (mean ± standard error)
					Anglo	Hispanic	Other		
<21 (n = 54)	24.1	57.4	29.2	75.0	77.8	18.5	3.7	81.5	3.35 ± 0.06
21–25 (n = 302)	19.6	92.6	48.2	77.9	78.8	16.9	4.3	42.2	3.40 ± 0.03
26–30 (n = 395)	17.7	95.9	49.5	87.6	84.6	11.9	3.5	22.8	3.52 ± 0.02
31–35 (n = 227)	13.7	95.5	47.7	87.4	84.6	11.9	3.5	15.9	3.53 ± 0.03
>35 (n = 44)	15.9	93.0	44.2	81.8	93.2	4.5	2.3	15.9	3.54 ± 0.07
p value	0.30	<0.0001	0.12	0.003		0.30		<0.0001	0.002

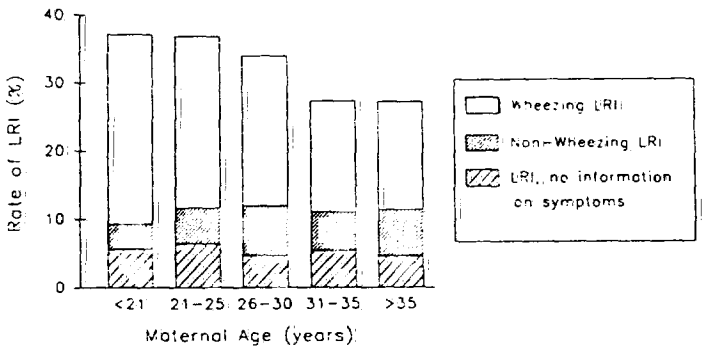

FIGURE 1. Relation between incidence of lower respiratory tract illnesses (LRI) during the first year of life and maternal age in 1,022 infants in Tucson, Arizona, between 1980 and 1984. Numbers of subjects for the five groups were 54, 302, 395, 227, and 44 for infants of mothers aged less than 21, 21–25, 26–30, 31–35, and greater than 35, respectively.

during a lower respiratory tract illness was ascertained directly by the pediatrician during physical examination in over 90 percent (200 of 222) of cases. For the remaining 22 lower respiratory tract illnesses, wheezing was reported to the pediatricians by parents.

There was a significant, inverse relation between incidence rate of lower respiratory tract illnesses in the first year of life and maternal age (figure 1; χ^2 for trend = 5.5, p = 0.02). A more detailed examination of figure 1 reveals that the incidence of non-wheezing lower respiratory tract illnesses was not associated with maternal age: rates for children of mothers aged less than 21, 21–25, 26–30, 31–35, and more than 35 years were 3.7, 5.3, 7.3, 5.7, and 6.8 percent, respectively (χ^2 for trend = 0.45, p = 0.5). The association between lower respiratory tract illnesses and maternal age was mainly due to the significant decrease in incidence rate of wheezing lower respiratory tract illnesses with increasing maternal age. With children of mothers aged more than 35 years as the reference category, the risk of having a wheezing lower respiratory tract illness during the first year of life was 2.0 times higher among infants of mothers aged less than 21 years; 1.8 times higher among infants of mothers aged 21–25; and 1.5 times higher among infants of mothers aged 26–30. The odds ratio for infants of mothers aged 31–35 was only 1.03. A χ^2 for linear trend was highly significant both when all five strata were included (χ^2 = 7.6; p = 0.006) and when maternal age groups 31–35 years and more than 35 years were combined (χ^2 = 7.7; p = 0.005). For these rea-

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TABLE 3. Incidence
infants by maternal a

Maternal age (years)
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26–30
>30

* LRI, lower respirato
† Odds ratios were c

TABLE 4. Rate of w
infants by maternal a

Maternal age (years)
<21
21–25
26–30
>30
Total

* Numbers in parent

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sons, these two groups were merged in all subsequent analyses.

Trends for the incidence of wheezing lower respiratory tract illnesses to increase with decreasing maternal age were seen for both sexes, but only reached statistical significance in males (table 3). No significant relation was observed between incidence of nonwheezing lower respiratory tract illnesses and maternal age for either sex (data not shown).

The incidence rate of wheezing lower respiratory tract illnesses was linearly correlated with birth order of the proband (table 4, last column; χ^2 for trend = 5.8, $p = 0.016$). When compared with firstborn children, the risk of having a wheezing lower respiratory tract illness in the first year of life was 1.2, 1.7, and 1.6 times higher for infants born second, third, or fourth or higher in the family, respectively. However, not surprisingly, older mothers tended to have more children than did younger mothers (Kendall's τ for nonparametric correlation between birth rank and maternal age = 0.24, $p < 0.0001$). Hence, we reexamined the relation of incidence of wheezing lower respiratory tract illnesses to both maternal age and birth rank after stratification by the other variable (table 4). Incidence of wheezing lower respiratory tract illnesses was associated with maternal age within all four categories of birth rank, and the rank-adjusted χ^2 for trend was 13.1, $p = 0.0003$, and thus was stronger than that obtained using the raw data. Incidence of wheezing lower respiratory tract illnesses was associated with rank within all categories of maternal age, except among children of mothers aged greater than 30 years. After adjustment for maternal age, trend χ^2 was 11.5 ($p = 0.0007$), which was also stronger than that obtained from the raw data.

Nonwheezing lower respiratory tract illnesses were unrelated to maternal age after maternal education and birth rank were controlled for.

A categorical logistic analysis (see Mate-

TABLE 3. Incidence (%) of wheezing lower respiratory tract illnesses during the first year of life for 1,022 infants by maternal age and sex, Tucson, Arizona, 1980–1984*

Maternal age (years)	Males				Females			
	No.	Wheezing LRIs*		Odds ratio†	No.	Wheezing LRIs		Odds ratio
		%	*p* value			%	*p* value	
<21	27	29.6		2.5	27	25.9		1.6
21–25	138	29.0		2.4	164	22.0		1.3
26–30	205	22.0		1.6	190	22.1		1.3
>30	130	14.6		1.0	141	17.7		1.0
			0.004				0.29	

* LRI, lower respiratory tract illnesses.
† Odds ratios were calculated using infants whose mothers were >30 years old as reference.

TABLE 4. Rate of wheezing lower respiratory tract illnesses (in %) during the first year of life for 1,022 infants by maternal age and by birth rank, Tucson, Arizona, 1980–1984

Maternal age (years)	Rank				
	1	2	3	≥4	Total
<21	25.0 (48)*	50.0 (4)	50.0 (2)	0.0 (0)	27.8 (54)
21–25	20.7 (164)	28.7 (101)	33.3 (30)	42.9 (7)	25.2 (302)
26–30	16.0 (189)	24.1 (133)	28.3 (53)	40.0 (20)	22.0 (395)
>30	16.0 (81)	12.7 (102)	23.7 (59)	13.8 (29)	16.2 (271)
Total	18.9 (482)	22.4 (340)	27.8 (144)	26.8 (56)	21.7 (1,022)

* Numbers in parentheses, number of subjects.

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rials and Methods) was performed to assess whether other possible confounders could explain the relation between maternal age and risk of having lower respiratory tract illnesses. The following predictor variables were thus added to the model together with maternal age and birth rank: maternal education (12 years or less or more than 12 years); feeding practices (bottle-fed or breast-fed); birth weight; day care (less than 9 hours per week or more than 9 hours per week in the company of other children); marital status (married or unmarried); ethnicity (Hispanic, Anglo, or other); sex; and maternal smoking (nonsmoker or more than one cigarette per day).

Figure 2 shows the odds ratios of having a wheezing lower respiratory tract illness for different maternal ages and the weighted, least squares linear regression fitted to the odds ratios. When compared with infants of mothers aged more than 30 years, adjusted odds ratios were 2.4 (95 percent confidence interval (CI) 1.8–3.1) for infants whose mothers were less than age 21 years ($p < 0.0001$); 1.8 (95 percent CI 1.4–2.3) for infants whose mothers were age 21–25 ($p < 0.0001$); and 1.4 (95 percent CI 1.1–1.6) for infants whose mothers were age 26–30 ($p < 0.001$). The same type of analysis was performed by using odds ratios for birth rank obtained from the categorical logistic regression. When compared with those for first-born children, odds ratios were 1.4 ((95 percent CI 1.1–1.7) for infants born second ($p = 0.002$); 1.8 (95 percent CI 1.3–2.4) for those born third ($p < 0.001$); and 2.2 (95 percent CI 1.5–3.3) for infants born fourth or higher in rank ($p < 0.001$). In addition to maternal age and birth rank, the following variables were independent risk factors for wheezing lower respiratory tract illnesses: maternal smoking (odds ratio (OR) = 1.7, 95 percent CI 1.1–2.5, $p = 0.01$); use of day care facilities (OR = 1.4, 95 percent CI 1.0–2.0, $p = 0.02$); being Hispanic (OR = 1.6, 95 percent CI 1.0–2.6, $p = 0.04$); and being an unmarried mother (OR = 1.8, 95 percent CI 1.0–3.2, $p = 0.06$).

There was still no significant relation between maternal age and risk of having nonwheezing lower respiratory tract illnesses after addition of the above mentioned variables to a logistic model.

There was no significant relation between cord serum immunoglobulin E levels and either maternal age or birth rank. Likewise, the development of eczema during the first

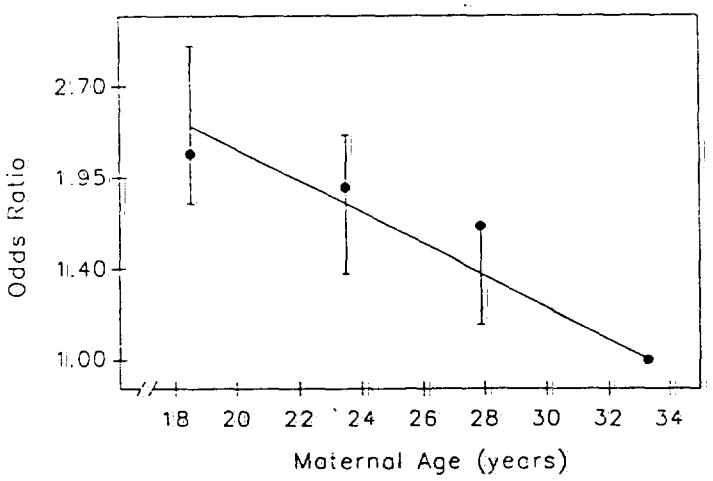

FIGURE 2. Odds ratio of having wheezing lower respiratory illnesses by maternal age after correction for other risk factors. A total of 1,022 infants were studied between 1980 and 1984 in Tucson, Arizona. The solid line is a weighted, least squares linear regression model fitted to the logarithm of the odds ratios for each maternal age group (less than 21, 21–25, 26–30, and greater than 30 years, respectively). Points, mean maternal age for each group; bars, 95% confidence interval around the regression for each odds ratio.

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DISCUSSION

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year of life was not significantly associated with birth rank and was not more likely to occur in infants of younger mothers.

DISCUSSION

In previous reports based on this population, we have shown that maternal smoking habits (11), room sharing and feeding practices (12), cord blood immunoglobulin E (13), and lung structure and function (14) are associated with the risk of developing lower respiratory tract illnesses (especially those associated with wheeze) during the first year of life. In this study, we add to the above list a new, important risk factor: younger maternal age. The risk increased linearly with decreasing maternal age, but the association was limited to wheezing lower respiratory tract illnesses; there was no relation between maternal age and nonwheezing lower respiratory tract illnesses. It was also stronger for males than for females.

Our results suggest that factors directly or indirectly related to maternal age increase the susceptibility of infants to wheezing, but not to nonwheezing respiratory illnesses. Because a viral etiology was ascertained for the vast majority of these two types of illnesses (6), we hypothesize that such factors ought not to be related to an increased general susceptibility to viral infection during the first year of life. If this were the case, we would expect the incidence of both types of lower respiratory tract illnesses to be inversely related to maternal age. This hypothesis is further supported by our previous finding that factors known to increase the risk for infection are associated with an increased incidence of both wheezing and nonwheezing lower respiratory tract illnesses in the first year of life (12). Specifically, we reported that infants who slept in the same room with other people were at increased risk of developing lower respiratory tract illnesses during the first 4 months of life (12). Room sharing is likely to increase the risk of viral respiratory infection in general, independent of the specific symptoms associated with it.

Very few studies have addressed the relation between maternal age and infant morbidity. Most studies have focused on infants of adolescent mothers, the prevalent idea being that these infants have more health problems than do infants born to older mothers (15). Outcome variables for most of these retrospective studies have been general indices of disease frequency such as number of hospitalizations in the first 3 (16) or 5 years of life (17). This detracts from the possibility of comparing their results with those reported herein. A report by Ogston et al. (18) is the only longitudinal study of which we are aware that is comparable with ours. These authors obtained retrospective information from parents about "respiratory illnesses" (without distinguishing between upper and lower respiratory illnesses) during the first year of life in over 1,500 infants born to primigravidas in Dundee, Scotland. They found a significant inverse relation between maternal age and incidence of respiratory illnesses during the first year of life, but the statistical significance disappeared after controlling for maternal smoking and other confounding factors. More recently, Schwartz et al. (19) studied a large sample (over 4,500 subjects) of the US population between the ages of 6 months and 11 years. They found a significant inverse relation between maternal age and prevalence of physician-diagnosed asthma, as reported by parents. This relation was still significant after controlling for age, sex, race, and birth weight. Prevalence of wheezing was also inversely related (albeit not significantly) to maternal age (19). The authors also found that maternal age appeared to be a stronger predictor of asthma for boys than for girls (19), much as we found that maternal age was a better predictor of wheezing lower respiratory tract illnesses in boys than in girls. The relation between lower respiratory tract illnesses and the development of asthma is very complex, but our results and those of Schwartz et al. (19) would indicate that young motherhood may be a common predisposing factor for both of these illnesses.

This predisposition does not seem to be mediated by an increased risk for developing

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allergies early in life in children of younger mothers. We found no association between maternal age and either cord serum immunoglobulin E levels or the risk of having eczema during the first year of life. Likewise, we were unable to confirm the finding by Strachan (20) that atopy (as assessed by cord serum immunoglobulin E levels or incidence of eczema in the first year of life) is more common in firstborn children. The different ages at which the subjects were studied and the different indices of atopy used in both studies may explain these discrepancies.

It is reasonable to argue that maternal age may be a proxy for some unknown social factor that we may have failed to consider in our analyses. We did not adjust our results directly for an index of social class derived from paternal or maternal occupation because it has been previously shown (21) that most of the variability in prevalence of respiratory diseases related to social factors is explained by level of education. More complex parameters of social level are highly correlated with the level of education and add little in statistical power to the analyses. The underrepresentation in our sample of infants from poorer backgrounds also argues against socioeconomic factors as an explanation for our findings. In addition, our results were independent of ethnicity, marital status, feeding practices, and maternal smoking habits, all of which are known to be related to or to be determinants of socioeconomic status. However, we cannot exclude the possibility that other social or environmental conditions (such as nutrition, quality of the house, and health status of the mother, among others) may have confounded the associations reported herein.

Perhaps more subtle aspects of the maternal-infant relationship are influenced by maternal age and may explain our findings. It has been suggested that younger mothers may provide a lower quality of care for their children during early infancy than older mothers (1). Jones et al. (22) found that younger mothers were less responsive than older mothers to their newborn infant's needs during the neonatal period. McAnarney et al. (23) were unable to confirm these findings, but, in a subsequent report, this group of researchers found that younger maternal age was associated with less favorable mothering behaviors when the infant was 9–12 months old (24). Interestingly, experimental studies have shown that mild stressful stimuli (such as subcutaneous injections of saline to suckling rats) may elicit long-term alterations in the mechanical characteristics of the lung (25). Younger mothers may also take less care of themselves during pregnancy and may thus increase the level of stress of the fetus. Naeye (3) suggested that the growth needs of young mothers may compete with the growth needs of their fetuses for available nutrients, and this may be a source of additional fetal stress. Fetal stress that persists for prolonged periods of time is known to be associated with increased endogenous cortisol secretion (26), and prenatal administration of corticosteroids has been shown to depress lung growth (27). These hypothetical pathogenetic mechanisms relating maternal age to fetal and infant stress and to lung development are relevant because we have shown previously that infants who subsequently had wheezing lower respiratory tract illnesses (but not those who only had nonwheezing lower respiratory tract illnesses) had diminished lung function long before any lower respiratory tract illness developed (14). We suggested that smaller lungs and/or smaller airways could predispose to wheezing during respiratory tract infections. On reanalyzing those results, we found that size-adjusted maximal expiratory flows at functional residual capacity were significantly correlated with maternal age in male (partial $r = 0.28$; $p < 0.05$) but not in female infants. There was no relation between functional residual capacity and maternal age (Fernando D. Martinez, University of Arizona, unpublished manuscript). This finding is compatible with the stronger relation we found between maternal age and incidence of wheezing lower respiratory tract illnesses in males (table 3). It is thus possible that factors associated with younger maternal age may affect lung development in the children of younger mothers and predispose
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It is important to note that our results may have been influenced by potential sources of bias in our data. Infants who had respiratory troubles during the neonatal period that required supplemental oxygen administration for more than 6 hours were not enrolled in the study (5). However, since low-birth-weight infants and those with neonatal complications are more often born to younger mothers (2) and are more apt to have respiratory infections during infancy (28), exclusion of these infants could perhaps decrease the significance of the reported findings. Likewise, because we limited our population sample to newborns enrolled in a health maintenance organization, households of lower socioeconomic status are probably underrepresented in our study; if anything, this makes it less likely that other socioeconomic factors, uncontrolled for in this study, may explain our results. There was a significant trend for younger mothers to stop using the study pediatricians more often than older mothers. For this tendency to explain our results, however, a direct relation between maternal age and wheezing lower respiratory tract illnesses, strong enough to reverse our findings, should be present among the minority of cases excluded from the analysis.

Finally, we need to consider the possibility that older mothers may be more experienced and thus less troubled by symptoms that may frighten younger mothers and may induce the latter to take their children to the pediatrician for less important illnesses. If this were the case, however, one would expect the incidence of both wheezing and nonwheezing lower respiratory tract illnesses to be inversely associated with maternal age, and this was not apparent in our data. In addition, the known inverse relation between maternal age and postneonatal mortality (2) would argue against overzealousness among younger mothers. In fact, some authors believe that young motherhood may be characterized by precisely opposite shortcomings, i.e., less ability to recognize serious illness and less access to medical care (1). Clearly, this issue requires further elucidation. However, it is safe to conclude from our data that infants of younger mothers may be at increased risk of having acute obstructive respiratory illnesses and that this may explain, at least in part, their higher postneonatal mortality rates.

In summary, infants born to younger mothers were reported by their pediatricians to develop clinically important signs of bronchial obstruction during viral infections more often than did those of older mothers. This was in part due to the significant association between lower maternal age and prevalence of known risk factors for wheezing lower respiratory tract illnesses. However, the association between maternal age and wheezing lower respiratory tract illnesses persisted after controlling for many of these known risk factors. A better understanding of the factors related to maternal age that predispose infants to develop wheezing lower respiratory tract illnesses may help in the prevention of this important cause of morbidity during the first year of life.

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Abbreviations: FEV ond, FVC, forced vit expiratory flow rate.

[1] Department of M University of British C of Excellence, Vanco
[2] International Un Disease, Paris, Franc

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